GYPSY MOTH NEWS

Northeastern Area

USDA
Forest Service

December 1989
Number 21

Gypsy Moth Defoliation in the USA 1949 - 1989

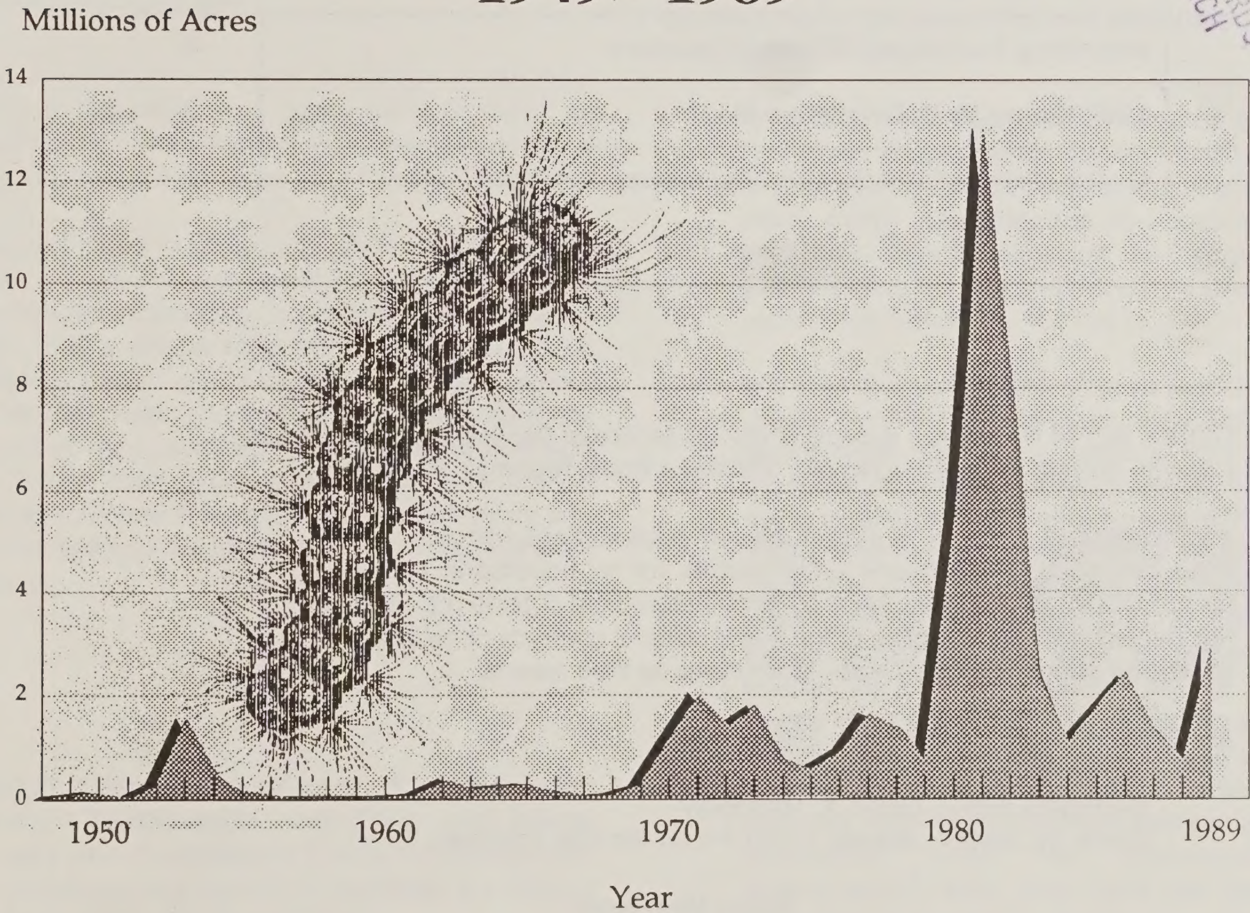


Table of Contents

GYPSY MOTH NEWS is a service of the USDA Forest Service, State and Private Forestry, Forest Pest Management, 370 Reed Road, Broomall, PA 19008.

It is distributed quarterly to individuals and organizations without fee. Products mentioned by name within articles are not necessarily endorsed by the USDA. Statements made by contributors from outside the USDA do not necessarily reflect policy of the USDA. Use of graphics or reprints of articles should cite the Gypsy Moth News as their source.

Address correspondence to the Editor.

Editor, Daniel B. Twardus
Managing Editor, Helen A. Machesky
Cover by James Lockyer, USDA Forest Service, Broomall, PA

Gypsy Moth News
USDA Forest Service
180 Canfield Street
Morgantown, WV 26505

FROM THE EDITOR

Gypsy moth-caused defolialtion approached 3 million acres in 1989. An impressive number, but not when compared to the 12 million acres defoliated in 1981. Each year at this time, the USDA Forest Service compiles and summarizes the extent of defoliation. The accompanying table illustrates these summaries for 2 years. Note the increases in defoliated acres throughout the generally infested range. Two States particularly standout in this summary, Michigan and Pennsylvania.

Next to larval abundance, defoliation is the most obvious indication of a gypsy moth problem. As used by the Forest Service, it is also an index of the magnitude of the problem. For 1989, the index is up!

Also, in this issue are several articles relating to the state of pheromone technology. Gypsy moth pheromone technology is certainly not new. In the early 1900's, efforts were first made to identify the chemical nature of the attractive materials emitted by female moths. Since that time, alot of effort has gone into using synthetic pheromones to both survey and control gypsy moth populations. Are we making progress? Several authors in this issue provide insight into the latest uses of pheromone technology.

D.Twardus

NOTICE: Effective December 18, the USDA Forest Service's Northeastern Area State and Private Forestry and Northeastern Forest Experiment Station headquarters located in Broomall, PA, will be moving to the following address:

5 Radnor Corporate Center, Suite 200
100 Matsonford Road
Radnor, PA 19087

LETTERS TO THE EDITOR

Darren Georgeff of the University of Minnesota, Dept. of Entomology, writes:

> **"I am most interested in results obtained through application of current risk/hazard rating models of newly infested locations. Are the models accurate? What modifications, if any, have been made?"**

Dr. Mark Twery, a research forester with the USDA Forest Service, responds:

> "We do not yet have the answers to your questions. Hazard rating models developed in Pennsylvania in the early 1980's are currently being tested against new data sets from West Virginia, Maryland, and Virginia, where the infestations and mortality are more recent, but the results are not in.
>
> We have also used some of those models to design treatments which we expect will make stands more resistant to damage from the gypsy moth. These treatments are currently being implemented in various parts of West Virginia and Virginia, and we do not expect to have results in for several years yet. The basic idea of these treatments is to either reduce the proportion of the stand in preferred species such as oaks enough so that the stands do not support large populations of gypsy moth (we currently think about 20 percent oak is a number to shoot for) or to remove the most vulnerable trees (either large, overmature oaks or intermediate, small-crowned oaks) and leave the stand more able to tolerate defoliation.
>
> Because testing silvicultural treatments is such a long-term proposition, many people will have to make decisions on their forests before our answers are conclusive, but the general recommendation of maintaining vigorous stands of mixed composition as a way to minimize pest damage should still apply well here."

Ted Kozlowski, Forester from White Plains, New York, writes:

> **"What is the status of Gypchek? Will it ever be available commercially?"**

From the Editor. See the Gypsy Moth News, Issue No. 20, August 1989, article by J. D. Podgwaite entitled, "Gypchek....When You Care Enough to Kill the Very Best!". Podgwaite writes:

> "So, where do we stand with Gypchek? The "improved" Gypchek tank mix is efficacious and ready for operational use. However, widespread operational use hinges on availability, cost, and to a lesser extent, ease of application. Current Gypchek production is a FS/APHIS cooperative project yielding 1500-3000 acre equivalents (AE) annually at a cost of $19/AE. Tank mix ingredients add another $1.95/AE. Application costs for a double application of 2 gal/A will vary, but will be higher than for a single application of Bt or Dimilin at lower volumes. The recent successful field tests have awakened commercial interests long held dormant in the face of questionable efficacy and uncertain markets."

For more information on Gypchek, Dr. J. D. Podgwaite can be contacted at the USDA Forest Service's Center for Biological Control at 51 Mill Pond Road in Hamden, CT 06514.

Brad Sample, West Virginia University, writes:

> **"I would like to see a consistent yearly list of acres defoliated and acres treated by State. Presently, this information is presented, but irregularly and not always at the same time."**

Helen A. Machesky, Managing Editor, responds:

> See page 8 of this issue. Also, the USDA Forest Service maintains an historical database of gypsy moth defoliation and treatments. Information from this database can be obtained by contacting the Gypsy Moth News.

GYPSY MOTH PHEROMONE TECHNOLOGY

R.E. Webb, M.N. Inscoe, and R.L. Ridgway
Insect Chemical Ecology Laboratory
Agricultural Research Service, USDA
Beltsville, MD 20705

The Pheromone

A pheromone is a chemical or blend of chemicals that is released by an organism and affects the behavior of other organisms of the same species. When the affected behavior involves attraction of a mate, the chemical is termed a sex attractant pheromone. Molecules of such a pheromone are released by the "calling" female gypsy moth and carried away on the wind. When these molecules reach receptor sites on the antennae of a downwind male, the male moth is stimulated to upwind zigzag flight and is led by the pheromone plume to the female (or to a pheromone-baited trap).

The gypsy moth pheromone was identified as *cis*-2-decyl-3(5-methylhexyl) octadecane(*cis*-7,8-epoxy-2-methyloctadecane) by Barbara Bierl (now Leonhardt) and coworkers of the Agricultural Research Service (ARS), USDA. The synthetic version of the natural pheromone is termed disparlure. Disparlure has a center of asymmetry and can therefore exist in two optically active forms (or enantiomers). Male moths respond most readily to (+)-disparlure, while (-)-disparlure acts as an inhibitor. As normally synthesized, disparlure is a 50:50 (or racemic) mixture of the (+) and (-) enantiomers; this racemic mixture is not as potent an attractant as (+)-disparlure because of the inhibition caused by the (-) enantiomer. (+)-Disparlure, while clearly superior to racemic disparlure as a male attractant, is much more expensive to synthesize. The current price per gram is about $0.30 for racemic disparlure and $200 for (+)-disparlure.

Since disparlure is a volatile compound that is subject to environmental degradation, specialized formulations are needed to release the material at a controlled rate and to protect it from degradation, thus providing the desired period of activity. ARS scientists have been involved in cooperative reserch on the development and evaluation of disparlure formulations since 1971. Dispensing systems

that have been investigated for various applications have included cork, microcapsules of various types, hollow fibers, laminated plastic rectangles or flakes, membrane-covered cups, and polymeric matrices.

Use of Disparlure for Monitoring

Long before the pheromone of the gypsy moth had been chemically identified, insect extracts containing the pheromone were being used as the lure in survey traps. At present, formulations of (+)-disparlure are used in over 200,000 detection traps throughout the uninfested portions of the United States in [the state-Animal and Plant Health Inspection Service (APHIS)] cooperative survey programs to detect and monitor gypsy moth infestations. Additional traps are also used in support of a variety of gypsy moth management programs, including the 12.8 million acre Appalachian Integrated Pest Management (AIPM) Program which is being conducted by Virginia and West Virginia by the U.S. Forest Service. Here, pheromone traps are being used to determine where egg mass surveys are needed.

Current trap/lure systems are useful primarily in low-density populations, since traps containing the standard detection lure fill up too rapidly in generally infested areas. Development of a trapping system that can be used to provide indications of relative population density in generally infested areas is currently under investigation. For this purpose, the use of dispensers having low rates of disparlure release to reduce trap captures is a promising area of current research by ARS scientists and cooperators.

Use of Disparlure for Suppression

Suppression of gypsy moth populations with disparlure can be achieved by mass trapping or by mating disruption, but both of these methods are most effective with low-density populations.

For mass trapping, traps baited with disparlure are deployed in large numbers over the suppression area. These can be very effective in capturing male moths, and in some small isolated low-density infestations, APHIS has obtained substantial evidence that elimination of the infestations has been achieved through mass trapping. However, mass trapping in high-density populations is not currently practical for suppresion, and the deployment of traps by homeowners in areas of high gypsy moth populations are not likely to have practical impact on the overall population.

The mating disruption technique consists of infusing the atmosphere with a "fog" of disparlure molecules so that the pheromone plumes from individual females are essentially hidden, thus interfering with the males' ability to locate mates. Population management by the "atmospheric permeation" technique has been successful with a number of insect species such as the pink bollworm, the oriental fruit moth, the codling moth, the European and the native grape berry moths, and peachtree borers. ARS research, in cooperation with APHIS scientists and state departments of agriculture, has demonstrated the potential of this technique for use against the gypsy moth and has shown that the less expensive racemic disparlure is as effective as (+)-disparlure for inhibiting gypsy moth mating in the field. Mating inhibition was found to increase with increasing concentrations of pheromone and to decrease (for a given dose) as the size of the gypsy moth population increased. Although high levels of communication disruption, as measured by relative reductions in trap captures, have been demonstrated at all population levels, actual inhibition of mating has been achieved only at low population levels. Isolated infestations of gypsy moths found within otherwise noninfested areas are logical candidates for mating disruption efforts with disparlure. Populations in the central core of the infestation could be suppressed with insecticides, while a large area around that core could be treated with disparlure with minimal effects on nontarget organisms. The mating disruption technique has been used with apparent success in some gypsy moth eradication efforts.

What Lies Ahead

Continued cooperative research among ARS, FS, APHIS, and university and industry scientists will lead to improved traps and alternative disparlure dispensers for use in specific applications and in high-density populations. Increased application of mating disruption will be made through improvements in the technique, including the development of better formulations and application techniques. This will be especially valuable in areas where mass trapping is not practical because of difficult terrain.

It is clear that the gypsy moth pheromone has had and will continue to have significant impact in management
programs.

GILES COUNTY DISRUPT PROJECT

John Ghent
USDA Forest Service
Forest Pest Management
Asheville, NC

In 1987, an isolated infestation of gypsy moth was discovered in Giles County, Virginia. The next year 12,500 acres were aerially treated with insecticides. A follow up 500-meter grid indicated that the initial treatment did not encompass the entire infestation. An additional 18,200 acres were selected for treatment in 1989. During a public scoping process, it was learned that research of the University of Virginia Mountain Lake Biological Research Station could be adversly affected by the use of insecticides in this area. Their research concerned the long-term study of the mating behavior of the dark-eyed junco. The major food source used in rearing its young is lepidopteran larvae, so the use of insecticides could seriously affect the research. Of the two available gypsy moth specific tatics, it was decided that only pheromone disruption would work in the low level populations. To protect the study area, a 2,550-acre area was selected for treatment. Due to the rough terrain and size of the project area, the use of aerially applied flakes was selected over hand treatment.

The project was a cooperative venture between the Virginia Department of Agriculture and Consummer Services and three agencies within the U.S. Department of Agriculture--Agriculture Research Service, Animal Plant Health Inspection Service (APHIS), Forest Service (FPM). Funding for this demonstration project was provided by the Appalachian Integrated Pest Management Project.

The material used was Disrupt II, manufactured by Health-Chem Corporation, Hercon Divsion. Disrupt II is a controlled release pheormone dispenser designed to confuse the normal male orientation to females. The active ingredient is (+/-)-disparlure. While the (+)-enantiomer of disparlure might be more effective, its cost precludes its operational use. The material was applied at the rate of 30.4 grams active ingredient per acre (75 g AI/h) with the sticker RA-1990 (Monsanto Co.).

How mating disruption works is not completly understood. There are indications that failure to locate a mate in air saturated with sex pheromone is the result of adaptation of the chemoreceptors of the male moth rather than disorientation. In other words, there is so much pheromone present in the air, that the male's antenna are no longer stimulated.

The half life of the material is reported to be approximately 40 days. With this short of period, it is important to time the application to just before moth flight begins. This allows more pheromone to be present during peak moth flight and later flights. In Giles County, we were fortunate to know from historic trapping data in the area when first flight had been detected. The application was made beginning July 19 and continued until July 21. Application was conducted by APHIS in a Cessna 206, with wing mounted applicators supplied by the manufacture.

There is no proven method to evaluate the success of this treatment. Since the project was an operational eradication project, rather than a research plot, it is difficult to have random assigned blocks and control areas. However, we did try to evaluate how the technique was performing.

Before the start of the project, milk carton traps were deployed on a 250-meter grid throughout the 2,600-acre area. In addition to this area, a check area was established along the Appalachian Trail in West Virginia with traps placed every 250 meters. This area was adjacent to the 1988 treatment area and had similar trap catches to the Mt. Lake treatment area. Three days before the beginning of the application, all traps were checked to insure that moth flight had not occurred. No moths were found. Sterile females were deployed in both the treatment and check area for 3 weeks. Females were left out overnight and retrieved the next morning. Two deployments were made each week. Females were collected and held in containers until eggs were laid. Six weeks later, eggs were checked for embryonation; an indication that mating had occurred.

First flight occurred in the check block after August 2, and continued for 2 more weeks. A total of 19 moths were trapped in the check area. No moths were trapped in the treatment area. None of the sterile females placed in the treatment area or check area were mated. The true measure of success or failure will depend on the next 2 years of trapping data. If the treatment area does not trap moths for 2 years, then elimination of this outbreak will be judged successful.

MASS TRAPPING-- AN ERADICATION TOOL?

Philip T. Marshall
Indiana Department of Natural Resources
Division of Forestry
Vallonia, IN

Does mass trapping eradicate an introduction of gypsy moth (GM) from an isolated area in a non-infested state? Mass trapping, the placement of GM traps at a high density (3-9 traps/acre), has been used in Indiana for several years as a third step in the detection of a GM introduction and the first step in eradicating an introduction. Each year a statewide detection survey is conducted to find GM.

Over 90 percent of the State has been surveyed the last 2 years using a 2-mile grid. When a moth is detected, the area around the find is delimited. If the delimit locates the introduction point and/or other life stages are found, the area is scheduled for eradication the following year. With the objective of the survey being to locate an introduction as quickly as possible and to eradicate that introduction when it is small, mass trapping serves as the transition from the detection survey to the application of eradication measures.

Since 1983, mass trapping has been used in eradication efforts in Indiana. It has been employed for the following reasons:

1. It helps to further define and locate the introduction.

2. It puts pressure on a small population with the intent to capture males before they find a female and to catch those that emerge before the female.

3. It is environmentally safe.

4. It can eliminate an introduction without having to apply a pesticide. If it fails to eliminate the introduction, the trap catch information more precisely defines the area to be treated and usually creates a smaller treatment area.

5. It is the next logical step in the survey for GM and would be used to verify the effect of a pesticide treatment.

Tippecanoe Lake in Kosciusko county has the only reproducing population in the State. Tippecanoe Lake is a large natural lake that is the origin of the Tippecanoe River which eventually drains into the Wabash River. The lake has summer and year round cottages and homes. An introduction was detected in 1984 with three moths found on the south side of the lake and one on the north side. In 1985, the delimitation survey caught 21 moths. No other lifestages or the point of introduction were found in 1985.

In 1986, mass trapping was begun to further define the introduction, and to begin eradication measures. The 1986 mass trapping located the point of introduction, trapped 79 moths, and found 1 female moth, 1 pupae, and 4 egg masses (1 old, 3 new).

With the point of introduction discovered (GM had been introduced by a family moving from New York) and multiple lifestages; eradication measures were needed. However, there was the environmental concern of applying pesticides next to the lake. Large trees and terrain did not afford an easy use of ground application. The use of aerial application meant spraying against the lake shore with the drift of the pesticide going into the lake. Thus, the decision was made to use mass trapping in 1987 to eradicate the introduction.

In 1987, a 12-acre area was mass trapped at the rate of 3 traps/acre. Around the mass trap a 0.1-mile grid delimit was placed, and around this delimit a 0.2-mile grid delimit was placed. In addition, trees were burlap banded. The mass trapping caught 53 moths. No moths were found outside the mass trap area. The burlap bands caught 48 larvae and 6 pupae. In addition, two larvae were found on leaves and two old egg masses were found during egg mass surveys. Thus, the mass trapping had reduced the number of moths caught with the help

from the burlap bands. However, the total number of lifestages found had increased, 85 to 109. This indicated that mass trapping was working and at least holding GM in place.

Based on the results of the 1987 mass trapping, the decision was made to mass trap with burlap banding in 1988.

The mass trapping caught 80 moths. As in 1987, no moths were caught outside the mass trap area. However, most of the moths were not caught around the point of introduction. They were found along the lake shore approximately 150 yards east. The burlap bands caught only 2 larvae and 2 pupae. The egg mass survey in the fall covered the mass trap area and found 10 egg masses.

From the 1988 eradication, the total number of lifestages decreased, 109 to 94, but GM had moved east. The mass trapping was containing GM but not moving toward eradication. The decision to apply pesticides in 1989 was not chosen because legal time requirements could not be met. Recent, changes in laws covering the Department's requirements prevented a timely and legal option for spray in 1989. So, the mass trapping would be repeated in 1989.

In 1989, the mass trapping was conducted on 7 acres at 9 traps/acre. Around this was a 0.1-mile grid delimit surrounded by a 0.2-mile grid delimit. Burlap banding was expanded with 151 trees banded. In addition, 20 trees that had eggmasses or were near egg mass trees had their lower boles sprayed with Dimilin in mid-June. The mass trapping caught 45 moths in the same area as 1988. Two moths were trapped on the north side of the lake for the first time since 1986. The burlap bands caught 1,011 larvae and 2 pupae primarily from the trees that had egg masses on them and the trees adjacent to them. Egg mass surveys have not been conducted at this time, but it is believed that mass trapping is containing the introduction and possibly beginning eradication. These assumptions are tempered by the fact that 1,058 lifestages were found compared to 94 in 1988, and that 2 moths were caught on the north side of the lake.

The decision for 1990 has not been totally made at this writing.

To return to the opening question, "Does mass trapping eradicate an introduction of GM?". I can answer yes when an introduction is weak or has poor habitat. However, for Tippecanoe Lake, a healthy introduction with good habitat, the question is not answered yet.

I believe mass trapping has shown that it is an integral part of a GM management program aimed at detecting GM quickly when it is small. It has served as a transition from detection to eradication. The work at Tippecanoe Lake has shown that integrated management is needed as several techniques have been used to eradicate this introduction, just not mass trapping alone.

Tippecanoe Lake has also shown that mass trapping may be more important in environmentally sensitive areas as it can better define the introduction and contain the introduction until spray programs can be prepared. The problems with mass trapping in a Statewide GM management program such as used in Indiana are the time demands and cost to mass trap each area and the increased number of locations that are expected to need mass trapping in the future as GM continues to be introduced into the State.

IMPROVING TREATMENT EFFICACY OF LURETAPE®

Bradley P. Onken
USDA Forest Service
Forest Pest Management
Morgantown, WV

Historically, resource managers facing the threat of a gypsy moth infestation have been forced to deal with the "spray or not to spray" syndrome of gypsy management. Although other methods of control are available under the guise of integrated pest management, few have proven very successful operationally. The purpose of this study was to modify and evaluate a mating disruption technique using ground applications of disparlure, in hope that treatment efficacy could be improved.

Gypsy moth pheromone dispensers or LURETAPE® is a disparlure mating disruptant product manufactured by Health-Chem Corporation, Hercon Division, and sold commercially for purposes of sup-

pressing low level gypsy moth populations. In 1988, LURETAPE® was deployed in the Jumonville Glen Management Unit of Fort Necessity National Battlefield located in Fayette County, Pennsylvania. The study area consisted of about 24 acres and was designed to evaluate the potential use of LURETAPE as a barrier as well as the more traditional method of treatment.

The study design was such that a 100-foot wide rectangular strip encompassing approximately 6.6 acres made up the treatment area. The untreated core of the rectangular strip was approximately 8.8 acres. The control area from which treatment effects would be compared, bordered the outside of the treated rectangular strip and consisted of approximately 18.6 acres.

Within each of the three areas, 12 1/40-acre plots were systematically distributed to quantify egg mass densities. Because the label states that LURETAPE® will release disparlure for more than 12 months, post-treatment egg mass surveys were conducted in the same manner in both 1988 and 1989.

The application consisted of deploying 2, 2x1.5-inch laminated plastic dispensers impregnated with a total of 996 mg of disparlure at 10-meter intervals and stapled to trees or branches at approximately 1 1/2 meters off the ground. The application rate was the maximum label recommended dosage of 40 grams disparlure active ingredient per acre.

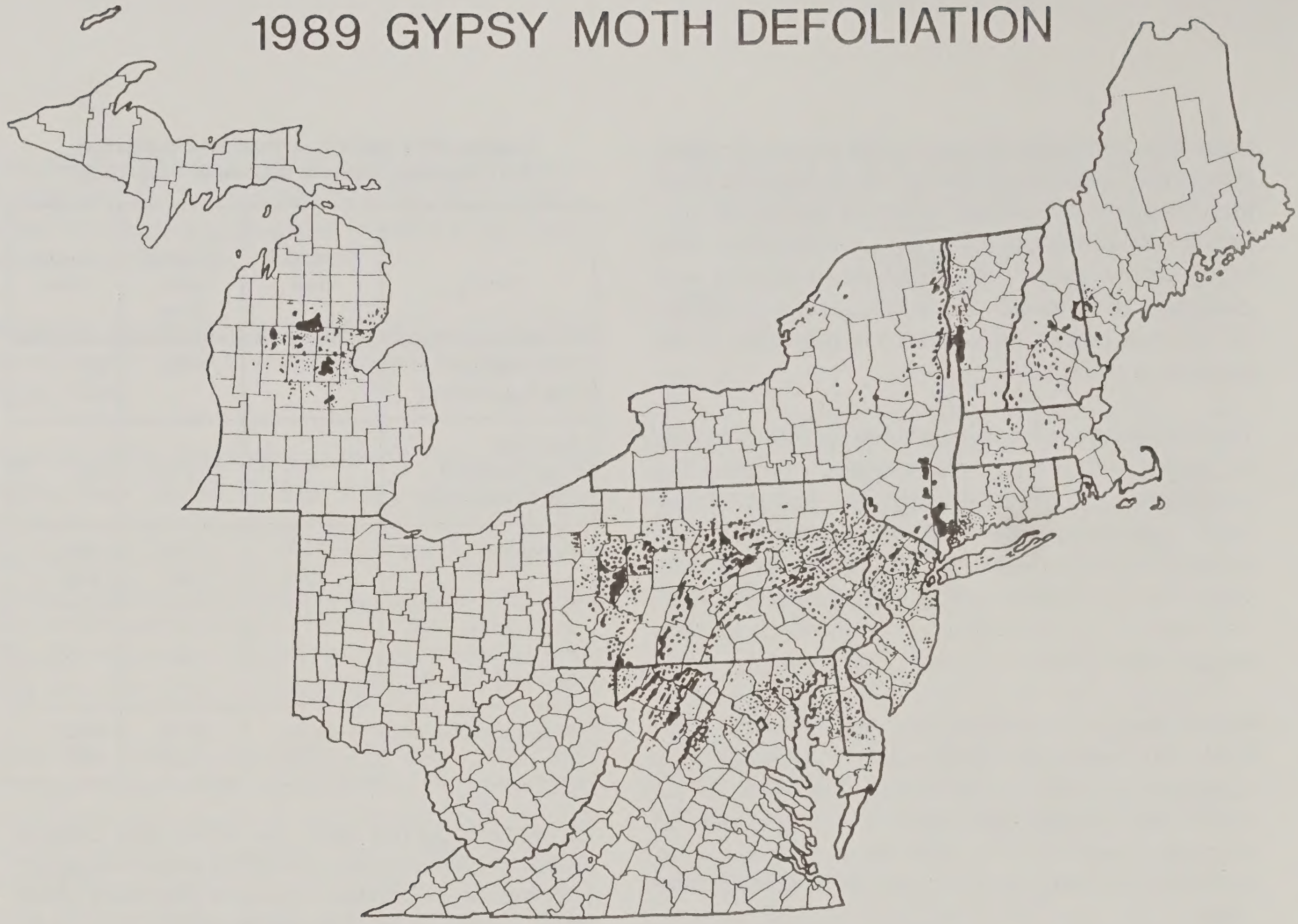
The results of pre- and post-treatment egg mass densities (egg masses/acre) are summarized in the table below.

Results of the Disparlure Treatment Evaluation, Fort Necessity National Battlefield, 1988-1989.

Timing	Treatment Area	Untreated Core Area	Control Area
Pre-Treatment Egg Masses/Acre	67	80	57
First Year Post-Treatment Egg Masses/Acre	170	213	230
Population Change	2.5X (Up)	2.6X (Up)	4.0X (Up)
Second Year Post-Treatment Egg Masses/Acre	6,147	4,427	9,707
Population Change	36.1X (Up)	20.7X (Up)	42.2X (Up)

As indicated in the table, the entire area became inundated with gypsy moth during the 2-year study. This was probably due to outside population pressures. From an operational viewpoint and under these conditions, the disparlure treatment did not succeed in reducing or even maintaining low level gypsy moth populations in either the treatment area or the untreated core area. The treatment did appear, however, to have had some effect on reducing the rate of increase. The barrier zone strategy, in particular, shows some potential and at least warrants further investigation. Future evaluations should be limited to more isolated low level infestations, well away from the generally infested area of the gypsy moth.

1989 GYPSY MOTH DEFOLIATION



GYPSY MOTH DEFOLIATION, SUPPRESSION, AND FOREST SERVICE ERADICATION ACREAGES

STATE	1988 DEFOLIATION	1989 DEFOLIATION	1989 SUPPRESSION
District of Columbia	0	0	501
Connecticut	1,639	78,430	0
Delaware	791	1,888	39,700
Idaho	0	0	380
Maine	100	35,000	0
Maryland	58,507	97,911	182,651
Massachusetts	0	950	0
Michigan	70,350	294,344	72,600
New Hampshire	1,015	18,395	0
New Jersey	7,430	137,310	16,246
New York	15,700	421,138	0
North Carolina	0	0	4,259
Pennsylvania	312,092	1,506,790	237,891
Rhode Island	725	0	0
Utah	0	0	1,200
Virginia	191,000	289,332	187,863
Vermont	703	27,335	0
West Virginia	59,250	86,736	75,696
Total	719,302	3,081,259	818,987

NOTE: Totals include defoliation and suppression acreages on Other Federal Lands, National Forests, AIPM Land, and Eradication Projects.

U.S. Department of Agriculture
Forest Service
5 Radnor Corporate Center
100 Matsonford Road
Radnor, PA 19087